EGU General Assembly 2022

EGU22-12095
https://doi.org/10.5194/egusphere-egu22-12095
EGU General Assembly 2022

Convective organization from the interaction between cold pools and thermally induced mesoscale circulations

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Land surface conditions can influence the onset and strength of convective systems. This is because sharp gradients in land surface properties result in the development of mesoscale atmospheric circulations that initiate convection, similar to the circulations present in land-sea breezes (Dirmeyer, 1995). The influence of these mesoscale circulations on convection has been well established, however, moist convection can also alter the circulations that led to its initiation - an aspect which has largely been neglected in the literature (Rieck *et al.,* (2015)). An implication that follows from the effect of moist convection on the circulations is that it is possible for the surface temperature gradient (which triggers the initial mesoscale circulation) to reverse under cold pool effects, thus reversing the direction of the mesoscale circulation in order to bring rain to conditionally unstable regions (such as wet soils). Under these conditions, how does the mesoscale circulation tie in with cold pool outflow to organize convection across a domain with heterogeneous surface properties?

Motivated by the modeling framework from previous studies (e.g. Huang and Margulis, 2012; Rieck *et al.,* 2015; Schneider *et al.,* 2019) we employ a checkerboard of alternating extremely dry vs. wet soil moisture patches in an idealized cloud resolving model coupled to a land surface model. The checkerboard approach has previously been used to show how the PBL, cloud size, precipitation duration and amount are all influenced by different strength and length scales of the land-surface gradients. Using this setup, mesoscale circulations induced by surface heterogeneities are therefore overlaid with cold pool circulations from subsequent afternoon convection. Our aim is to investigate the role of the interactions between thermal mesoscale and cold pool circulations to organize diurnal convection in a way that allows upscale growth of scattered convection in an environment where background wind is absent. Originating from this we aim to understand 1) whether convection over wet patches is determined by convection first triggering over dry patches, 2) What are the conditions required so that the static thermal circulation (controlled by the soil moisture discontinuity) will change direction? 3) To what extent does the interaction between cold pool outflow and mesoscale circulations maintain the initial soil

moisture gradient field in the absence of background wind? These questions may help answer how land use changes (due to deforestation, agriculture etc.), and the resultant circulation changes focus convection so that rainfall becomes locally more extreme.